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Removal of contraceptive pill and HRT residues from water using ligno-cellulosic materials

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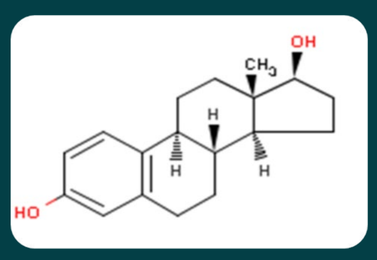
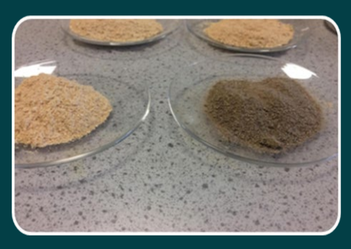
Introduction

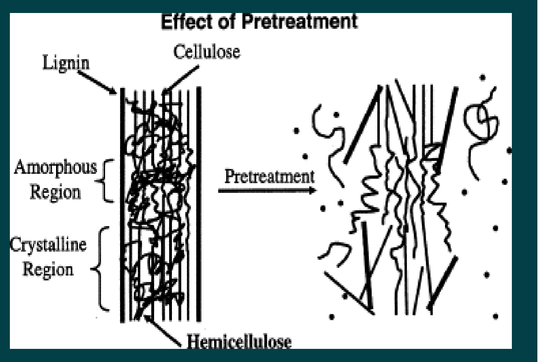
- The presence of oestrogen residues in rivers and lakes has been a global concern for decades.
- Residues of the contraceptive pill and hormone replacement therapy have been found in waste waters.
  - 17β-oestradiol (E2)
  - 17α-ethynyloestradiol (EE2)
- These oestrogen residues disrupt the natural function of humans and wildlife and are called endocrine disrupting chemicals (EDCs) (WHO, 2018).



Structure of 17β-estradiol (E2), the most potent oestrogen. Residues of E2 are found in waste waters, reservoirs, rivers and lakes

- Lignocellulose is the woody material that gives plants their rigidity and structure and comprises three main types of carbon-based polymer
  - cellulose
  - hemicellulose
  - lignin
- <u>Benefits</u>
  - readily available as a waste material
  - economically feasible
  - environmentally friendly solution that has previously shown promising results (Sciban et al, 2006)





Aim and Objectives

The aim of this study is to investigate the removal of oestrogens from water using lignocellulosic materials (namely sawdust).

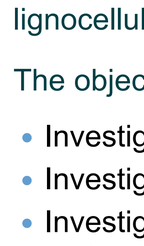
The objectives include:

- Investigate the effects of physical pre- treatment on sawdust
- Investigate the effects of chemical pre-treatment on sawdust
- Investigate the effect of initial mass of sawdust, reaction time, pH and temperature on the removal of E2 from water.

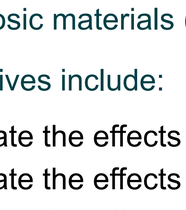
Methods

1. Stock solution of E2 100mg/L made up and standards of E2 1-10mg/L to obtain calibration curve using fluorescence spectroscopy.
2. Physical pre-treatment of sawdust by grinding the sawdust to 300-600 microns.
3. Chemical pre-treatment of sawdust using salts and acids.
4. Batch Tests with sawdust carried out to investigate the following parameters:
   - Mass of adsorbent
   - Time
   - pH
   - Temperature

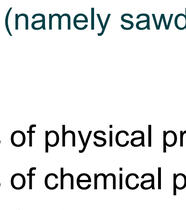
Physical pre-treatment



Blended

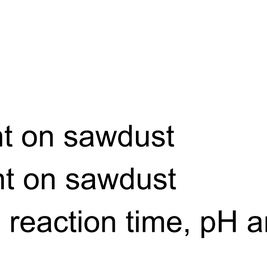


Washed



Sieved

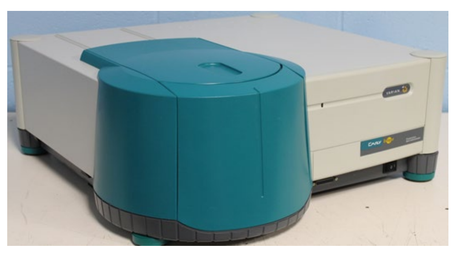
Chemical pre-treatment



Batch Tests (effect of mass, time, pH and temperature)

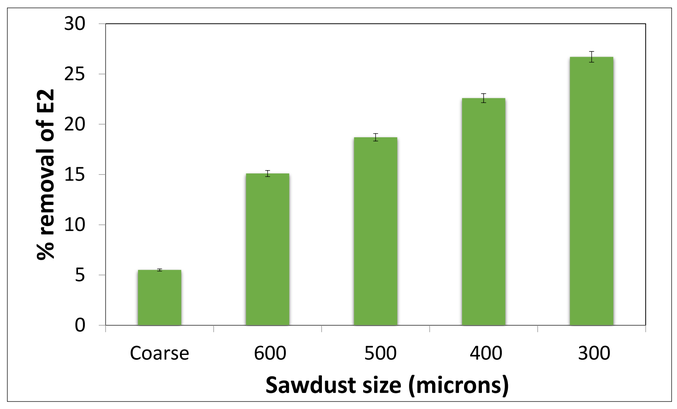
Triplicate samples on orbital shaker

Filtered samples

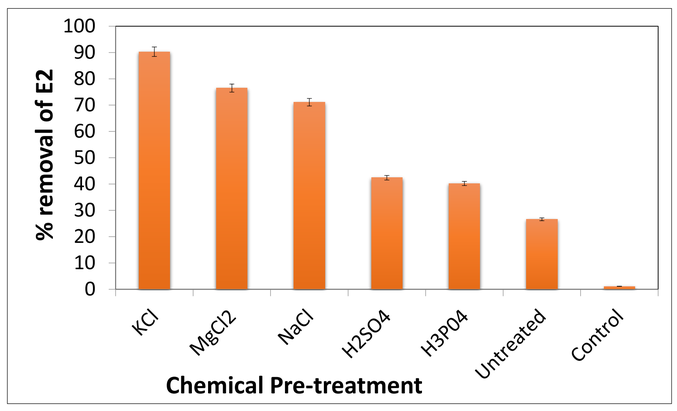


Analysed by fluorescence spectroscopy

Effect of physical pre-treatment of sawdust

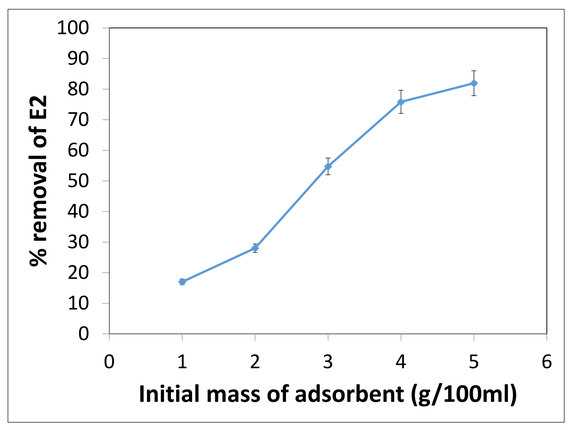


Effect of chemical pre-treatment of sawdust

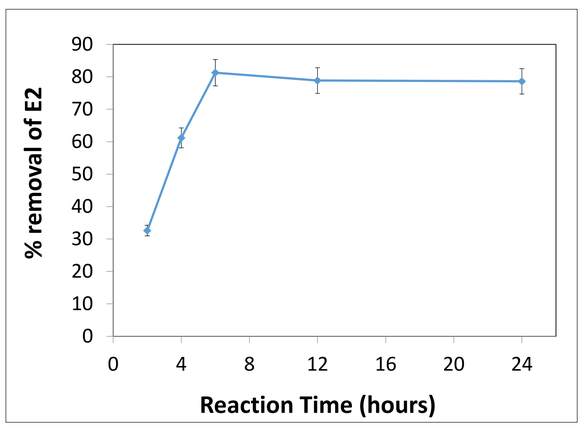


- Increases pore size
- Disrupts the lignin structure
- Exposes more binding sites to increase the removal capacity of E2 from water

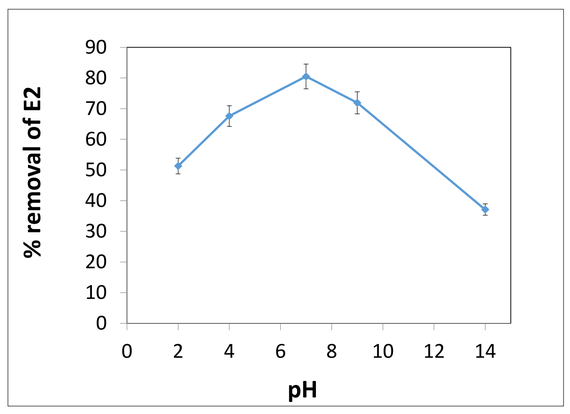
Effect of mass of adsorbent



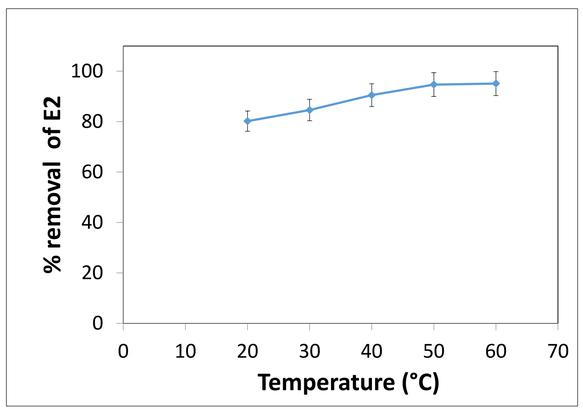
Effect of reaction time



Effect of pH



Effect of temperature



Summary of results

Parameter	Optimum conditions
Physical Pre-treatment	300 microns
Chemical Pre-treatment	Salts- KCl
Effect of adsorbent concentration	5 grams/100mLs
Effect of Reaction time	6 hours
Effect of pH	7
Effect of Temperature	60° C

Conclusions

- Lignocellulose (sawdust) as a bio-adsorbent has shown to be effective in removing oestrogen residues from water.
- Physical and chemical pre-treatment of sawdust showed clear benefits in increasing the adsorption capacity.

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- Sciban, M., Klasnja, M. and Skrbic, B. (2006). Modified softwood sawdust as adsorbent of heavy metal ions from water. *Journal of Hazardous Materials*. B136, 266–271.